

# **Results of a Survey on Seafood Collection and Consumption from the Shores of the Duwamish River and Elliott Bay**

*Jim Simmonds, Sydney Munger, John Strand, and Craig Homan*  
*King County Department of Natural Resources*

*Sue Robinson, John Toll, Charlie Wisdom, Paul Seidel, Heather Greer, and Janice Shroy*  
*Parametrix, Inc.*

## **Introduction**

The Duwamish River and Elliott Bay are highly developed urban water bodies within the city of Seattle that still sustain large recreational fisheries (NOAA, 1987; WADOH, 1985). Many steps have already been taken to remediate chemically contaminated sediments and reduce the release of toxic chemicals in the area. However, chemical contamination in seafood collected from the Duwamish River and Elliott Bay continues to be observed. The presence of potentially toxic chemicals in seafood from the Duwamish River and Elliott Bay raises concern about the level of risk to recreational anglers posed by eating chemically contaminated seafood collected in this area. These individual risk levels can be estimated using standard risk assessment techniques.

King County is conducting the Duwamish River/Elliott Bay Water Quality Assessment to assess potential risks to people arising from exposure to chemicals or pathogens, to wildlife from chemicals and to aquatic life from chemicals and physical stressors (e.g., low dissolved oxygen) in the river and bay (King County, 1997). The Water Quality Assessment is also estimating the relative proportion of risks contributed by CSO discharges. As part of this project, human health risks from exposure to chemicals through consumption of chemically contaminated seafood are being estimated.

To estimate chemical exposures from seafood consumption both the chemical concentrations in seafood and the amount and type of seafood consumed must be estimated (USEPA, 1989). A comprehensive sampling and analysis program was implemented by King County to obtain chemical concentration data in the tissues of salmon, rockfish, English sole, mussels, shiner perch, red rock crab, prawns and squid. A seafood collection and consumption survey was also conducted to estimate the types and amount of different seafood collected and consumed from the river and bay.

Several studies have been conducted that examined seafood collection and consumption in Puget Sound (NOAA, 1987; WADOH, 1985; Toy et al., 1996; Pierce et al., 1981). These studies suggest that many people continue to collect seafood from Puget Sound, both from the shore and from boats. Two of these studies included surveys of fishers in Elliott Bay (NOAA, 1987; WADOH, 1985).

The survey conducted by King County was designed to supplement the information collected from Elliott Bay during the mid-1980s. King County surveyed individuals collecting seafood from the shores of the river and the bay. Boaters were not interviewed because limited boat fishing is expected to occur within the bay, especially for salmon, because of restrictions on the boat fishing salmon harvest. The survey was designed to provide data from which we could calculate seafood collection and consumption rates. These data will be used in the risk assessment to assess whether there are risks to people from consuming seafood from the Duwamish River and Elliott Bay, and the fraction of the risks attributable to CSO discharges.

## **Methods**

Seafood collection and consumption was estimated for people that collected seafood from the shores of the Duwamish River and Elliott Bay. Both resident and nonresident anglers were surveyed, although it is believed that nonresident anglers will collect and consume seafood from the area less frequently than resident anglers. No effort was made to identify whether the angler possessed the proper license, or was otherwise illegally collecting seafood.

Surveyors were trained on filling out the forms and approaching potential respondents. Surveyors wore no badges, caps, or other items that identified them as county employees. Surveyors worked in teams of two, and approached every individual they observed collecting seafood within the study area. The survey form was translated into three languages to allow for persons uncomfortable with English to participate in the survey.

Locations where seafood collection could potentially occur were identified during a pre-survey site reconnaissance. These access sites were used as survey locations. During the survey, each of these identified access sites were visited at least twice (AM and PM) each survey day.

Surveys were conducted on 30 days during a 10-week period beginning Sunday, June 22, 1997, and ending Saturday, August 30, 1997. Surveys were conducted every Saturday and Sunday (10 days each), and on 10 weekdays. Weekend days were emphasized because the reconnaissance and results of other surveys (e.g., NOAA, 1987) indicated that a substantially larger number of people collected seafood on weekends.

Each survey day was divided into two shifts. On weekends the first shift began at 5 AM and lasted until 1:00 PM and the second shift began at 12:00 PM and lasted until 8:00 PM. On weekdays the first shift went from 5:00 to 11:00 AM, and the second shift lasted from 4:00 to 10:00 PM. Each shift visited every access point at least once. In an attempt to obtain more complete results, access points with the heaviest activity (i.e., Seacrest Park, Elliott Bay Pier, and Harbor Island) were often visited more than once during a shift.

## **Survey Design**

The design of the survey focused on asking anglers the types of seafood they collected and consumed from the study area, and how frequently they did so. The survey consisted of a three-page questionnaire filled in by the surveyor. When allowed, surveyors also identified, measured and weighed any organisms already collected.

Each respondent was asked whether they had previously participated in the survey, and whether they were willing to participate in the survey that day. Even when an angler declined to participate, some information was often gathered. Each angler was also asked to report age, sex and ethnicity.

To provide data on consumption rates, each angler was asked how frequently they collected and consumed seafood from the survey location each month of the year. Recall questions on the type and quantity of seafood collected and consumed during the past week were also asked. For any organisms collected the day of the survey, their plans for use were investigated. If the angler anticipated consuming the organism, the number of people with which they would share it was asked, as was their anticipated preparation method, and whether anybody sharing in its consumption would be under 10 years old.

## **Results**

A total of 1,947 interviews were attempted during the survey. Many people were approached more than once. Fewer than 1,183 different individuals were approached, with the rest of the interviews being repeat contacts. About 81% of the different individuals agreed to be interviewed on the first time they were contacted, while 19% of the 764 repeat contacts agreed to be interviewed. This resulted in an overall success rate of about 56%. However, the surveyors were often able to gather information for many questions even when the person declined to be interviewed. There were also instances when some questions were not answered, even after the person agreed to be interviewed.

Repeat interviews were more successful when the interviewer was female (34% success) versus male (5% success). No obvious differences in success rates were observed between male and female interviewers on initial contacts. With only 92 of the 1,947 survey responses indicating a communication problem, the use of English-speaking interviewers did not appear to limit our ability to adequately conduct the survey. The majority of the interview attempts took place between either 5 to 10 AM (700 attempts) or 4 to 8 PM (645 attempts).

## Survey Locations

A total of 24 survey locations were identified during the initial reconnaissance. Of these, three locations shown on Figure 1 (Seacrest Park in West Seattle, Elliott Bay Pier at the northwest end of Myrtle Edwards Park, and Harbor Island) accounted for 92% of the interview attempts (1792 out of 1947 surveys). Fewer than 35 people were interviewed at each of the remaining sites.

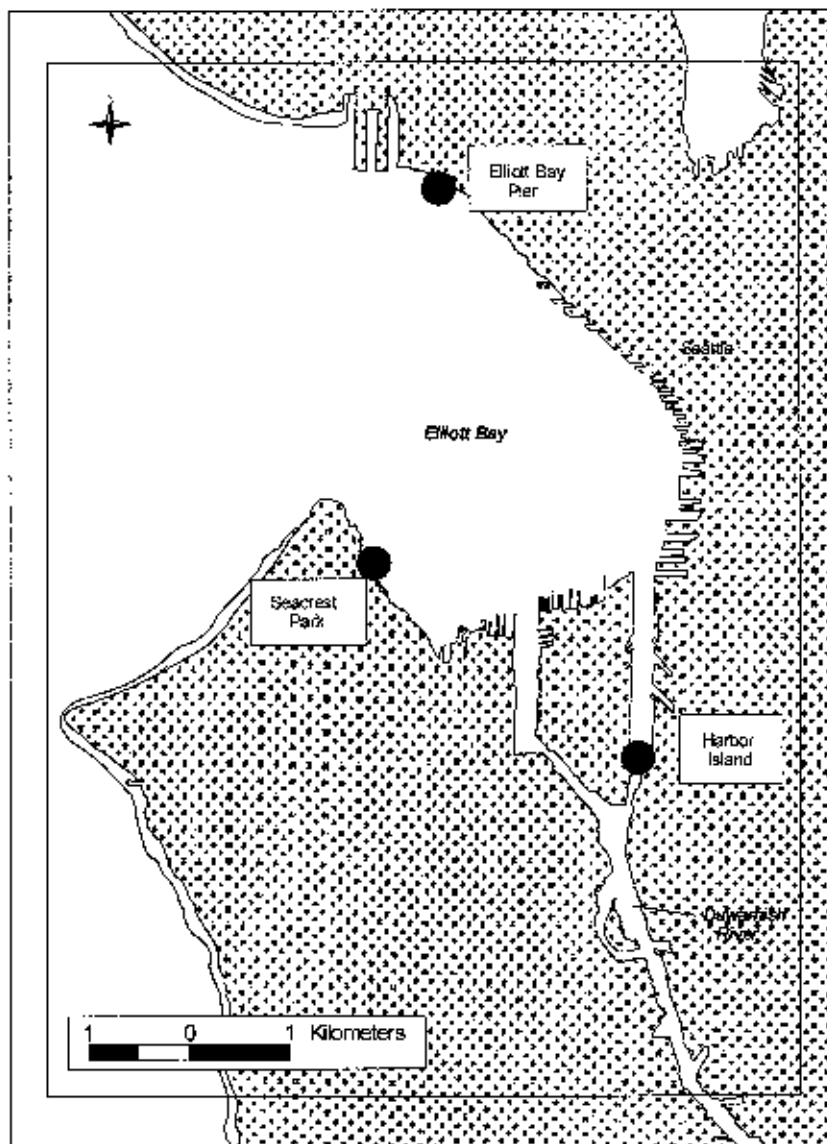


Figure 1. The three most popular seafood collection sites along the shores of the Duwamish River and Elliot Bay in Seattle, Washington.

## Age and Sex

The majority of the people surveyed were male (85%) and either 15 to 30 years old (35%) or 30 to 50 years old (43%). Smaller percentages of people surveyed were less than 15 years old (7.7%) or over 50 years old (11%).

## Ethnic Background

The majority of the respondents were Caucasian (41%), followed by African American (11%), Filipino (7.8%), Japanese (6%), Vietnamese (5.8%), and Chinese (4%). A wide variety of other ethnicities were also reported.

## Time Spent Collecting Seafood

The lengths of time that the people had been collecting seafood when the surveys began were indicated on 1,093 of the 1,947 survey forms. The majority of the people surveyed (53%) had collected seafood for less than one hour. Twenty-one percent had been collecting for one to two hours, and 21% had been collecting between two and five hours. Less than five percent had been collecting for greater than five hours when the survey was conducted. Three people responded that they had been continuously collecting seafood for between 15 and 30 hours.

## Seafood Collection Frequency

The majority of the people interviewed collect seafood only in the summertime, although approximately 10% of the people responding collect seafood every month of the year (Figure 2). These results were combined with the frequency that they collect each month to estimate the number of days they collect organisms from the survey location each year (Table 1). Approximately 53% of the 948 different people responding collect seafood less than 12 times per year, about 29% collect between 12 and 52 times per year, and 18% collect more than 52 times per year.

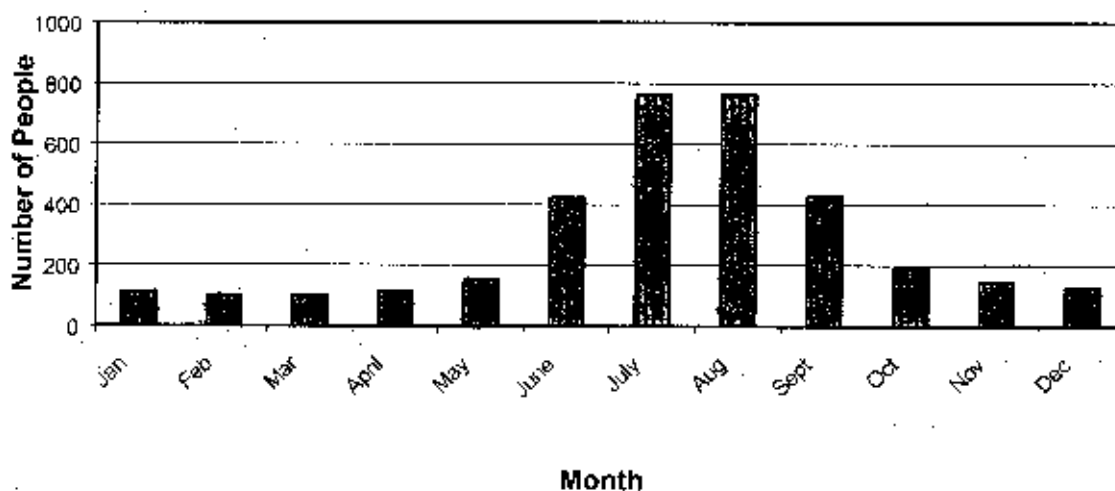


Figure 2. Number of people that collect seafood each month (out of 947 unique respondents)

## Seafood Consumption

About 97% of the 942 people responding indicated that they eat seafood. However, only 78% of the respondents stated that they eat seafood that they collect themselves, and only 452 people indicated that they eat seafood from the survey location.

We assumed that people that consume seafood would do so each month that they collect seafood. Based on this assumption, we combined the data on the months that people collect seafood with data on the number of meals they consume each month to estimate the number of days they consume organisms from the survey locations. Most (57% of the 452 people that said they eat seafood collected from the survey locations) consume seafood less than 12 times a year (Table 1). However, a large range was

observed, with twelve people stating that they eat seafood from the Duwamish River or Elliott Bay at least every other day, including seven that consume seafood every day.

Table 1. Frequency with which 1,183 people collect and consume seafood from the survey location.

Frequency (days/year)	Collect Seafood		Consume Seafood	
	Number of People <sup>a</sup>	Percent Of People <sup>a</sup>	Number Of People <sup>a</sup>	Percent of People <sup>a</sup>
0	0	0	466	39.5
0.1-0.9	10	0.8	1	0.08
1 - 1.9	230	19.4	78	6.6
2 - 5.9	174	14.7	114	9.6
6 - 11.9	87	7.4	65	5.5
12 - 23.9	118	9.97	69	5.8
24 - 51.9	157	13.3	72	6.1
52 - 179.9	140	11.8	41	3.5
180 - 365	32	2.7	12	1.0
No Response	235	19.9	265	22.4

<sup>a</sup> out of 1,183 people surveyed.

## Seafood Collected

When asked whether they had recently collected seafood that had not been recorded on any survey, 209 people said that they had collected one or more type of seafood from the survey location. Of these 107 people reported that they had collected salmon, 27 collected crabs and 21 collected flounder. Dogfish, herring, ling cod, shrimp, perch, squid, rockfish, sole, sculpin, octopus, sturgeon and candlefish were each caught by fewer than 20 people.

Table 2. Number of people that had collected each species of seafood, and the number and weight collected.<sup>a</sup>

Species	Number of people that collected each species	Number collected	Total weight (pounds)	Average weight per organism (pounds)	Average seafood weight per person who collects (pounds)
Halibut	1	4	3	0.75	3
Clams	1	25	6	0.24	6
Crabs	42	148	>90.2	0.61	2.1
Flounder	12	15	8.4	0.56	0.7
Gunnel	1	1	0.25	0.25	0.25
Herring	8	55	5.1	0.09	0.64
Ling cod	1	1	ND	ND	ND
Shrimp	11	282	>6.25	0.02	0.57
Moon snail	1	1	ND	ND	ND
Perch	19	238	>61.3	0.26	3.23
Squid	2	7	5.1	0.73	2.55
Rockfish	9	9	8.75	0.97	0.97
Sole	11	22	5.6	0.25	0.51
Salmon	33	34	>364.25	10.7	11.04
Sculpin/bullhead	9	10	2.6	0.26	0.29
Candlefish	1	30	ND	ND	ND

ND = No data available

<sup>a</sup>Out of 1,218 people responding

When asked whether they had collected seafood on the day they were interviewed 1,218 people responded. Of these, about 14% had successfully collected any seafood. However, the actual success rate is likely to be higher, because the people interviewed generally continued to collect seafood after the interviews. Initial review of the data indicates a greater success rate for longer collection times.

The number of people that had already collected seafood, the number of each species collected and the total and average weights of each seafood type collected are presented in Table 2. The species collected by the most people were crabs, followed by salmon and perch. Although collected by fewer people, shrimp and perch, along with crab, had the highest numbers collected. Salmon contributed the greatest portion, by weight, of seafood collected (64% of the total), followed by crabs (16%) and perch (11%). Seacrest was the most productive site, with more (numbers and pounds) of crab, shrimp, perch and salmon collected here than at any other location.

### **Planned Use of Collected Seafood**

One hundred and thirty four people indicated during their interviews what they intended to do with the seafood that they had collected. Most (74 of 134) of these people stated that they planned to eat their catch and share it with others. The remaining people stated that they would eat the seafood alone, use it as bait, release it, give it away, or responded “other.” When asked about the number of people that would share the meal, 87 people stated that they would share the seafood with a total of 365 people. Twenty-seven respondents also stated that they would share the seafood with children under the age of 10.

When asked what parts of the fish would be eaten, 43 out of 69 people responding (62%) stated that they would eat the meat only, 20 said that they would eat the meat and skin, and six said they would eat the whole fish. When asked what parts of the shellfish would be eaten, all (43 out of 43) respondents said they would eat the meat only.

Baking or frying fish was preferred 4:1 to grilling fish. Other fish preparation methods (e.g., boiled) were even less preferred. Crabs, shrimp, and clams were usually boiled or steamed.

## **Discussion**

Based on the questions on consumption frequency, 50% of the 452 people responding that they eat seafood from a specific survey location less than eight meals a year. The national mean intake of seafood per meal is estimated to be about 4 to 4.5 ounces (117 to 129 grams), while the 95<sup>th</sup> percentile<sup>1</sup> intake ranges from about 10 to 11.5 ounces per meal (284 to 326 grams per meal) (USEPA, 1996). Using these estimated meal sizes, 50% of the people consume an average of less than 36 ounces per year (1 kg per year) to a 95<sup>th</sup> percentile of about 86 ounces per year (2.4 kg per year) of seafood from the survey locations each year. These consumption rates are similar to the estimated average consumption rates for recreational marine anglers of 25.7 to 91.7 ounces per year (0.73 – 2.6 kg per year) (USEPA, 1996).

Using the same average and 95<sup>th</sup> percentile seafood meal sizes, the seven people who consume seafood from the survey locations every day consume an average of about 102.6 pounds per year (46.6 kg per year) and a worst-case scenario of about 245 pounds per year (111 kg per year). These consumption rates are substantially larger than the worst-case consumption rates for recreational marine anglers of 21 pounds per year (9.5 kg per year) (USEPA, 1996). These consumption rates are similar to those estimated by the USEPA (1996) for subsistence populations. This indicates that there is a small population of people that collect seafood from the shores of the Duwamish River and Elliott Bay that may be considered “subsistence” anglers (USEPA, 1996).

The 452 people that consume study area seafood eat a grand total of 11,354 seafood meals from the Duwamish River or Elliott Bay per year. Of these, the seven people that eat one seafood meal per day (1.5% of the respondents) account for 20% of the total number of meals of Duwamish River/Elliott Bay seafood each year. Similarly, 42% of all such meals are consumed by 27% of the respondents (125 out of 452 respondents).

The size of the population that consumes seafood collected from the shores of the Duwamish River and Elliott Bay is actually larger than the observed population (Price et al., 1994; USEPA, 1996). We have not estimated the total population of people that collect and/or consume seafood from the shores of the Duwamish River and Elliott Bay because it is likely that the average exposures for the total population will be below the average exposure for the observed population. For risk assessment purposes, use of conservative exposure estimates is warranted.

The type of seafood collected is expected to vary throughout the year. For example, returning salmon may only be caught from the shores of the river and bay during the summer and fall. Squid are fished during the winter, when they come close to shore to feed and spawn. Blackmouths (juvenile salmon) are caught during the winter only. These changes in seafood availability likely influence the numbers of people that collect organisms each month and the chemical concentrations to which people are exposed. An informal inquiry into the squid fishery indicates that many people that collect squid during the winter do not collect seafood during the summer. This implies that Figure 1 may underestimate angler pressure in winter months.

## **References**

- King County. 1997. Duwamish River and Elliott Bay water quality assessment: problem formulation. Draft. King County Department of Natural Resources. Seattle, WA.
- National Oceanic and Atmospheric Administration (NOAA). 1987. Potential toxicant exposure among consumers of recreationally caught fish from urban embayments of Puget Sound: final report. NOAA Technical Memorandum NOS OMA 33. Rockville, MD. April.
- Pierce, D., D.T. Novello and S.H. Rogers. 1981. Commencement Bay seafood consumption study. Preliminary report. Tacoma-Pierce County Health Department. Tacoma, WA. December.
- Price, P.S., S.H. Su and M.N. Gray. 1994. The effect of sampling bias on estimates of angler consumption rates in creel surveys. *Journal of Exposure Analysis and Environmental Epidemiology*. 4(3):355-372.
- Toy, K.A., N.L. Polissar, S. Liao and G.D. Mittelstaedt. 1996. A fish consumption survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region. Tulalip Tribes, Department of Environment, 7615 Totem Beach Road, Marysville, WA 98271.
- United States Environmental Protection Agency (USEPA). 1989. Risk assessment guidance for Superfund, volume 1, human health evaluation manual (part A). Interim Final. Office of Emergency and Remedial Response, USEPA. Washington, D.C. EPA/540/1-89/002.
- United States Environmental Protection Agency (USEPA). 1996. Exposure factors handbook. Volume II: food ingestion factors. USEPA, Washington DC.
- Washington State Division of Health (WADOH). 1985. Recreational and subsistence catch and consumption of seafood from three urban industrial bays of Puget Sound: Port Gardner, Elliot Bay and Sinclair Inlet. Olympia, WA. January.

---

<sup>1</sup> The 95<sup>th</sup> percentile intake rate represents an intake rate that is greater than that sustained by 95% of the people. This value is an approximation of the maximum consumption rate.